THE SCIENCE AND TECHNOLOGY OF UXO REMOVAL AND SITE REMEDIATION

ATR Workshop Report

11 November, 1999

Discussions

- Current process and status
- Sensors
- Data
- Algorithms

"History"

- Studies have shown that digital recording and post-processing can improve detection and reduce false alarms when compared to mag and flag (JPG studies, MTADS demonstrations)
  - Necessary for archival record
- Several groups have demonstrated promising algorithm/sensor combinations on various data sets, but all require post-processing.

Initial Thoughts

- ATR application requires fundamental change in the way data is collected
  - Digital offline processing or
  - Mag/Flag followed by re-acquisition and data collection
- No algorithms have been tested on data taken by any sensor on Kaho'olawe to date, thus no "silver bullet" tomorrow
- Algorithm and sensor are intertwined

"Current" Sensor Applicability Chart

Sensor	Usability	Sensitivity	Portability	Afford-ability	Avail-ability	Dur-ability	Infor-mation Content
MTADS	L	H	L	M	Y	H	M
MTADS-MPS	H	H/M	H/M	H	Y	H	M
EM61	H	H/M	H/M	H	Y	H	M
EM63*	M	H	H	N	SOON	H/M	H
TM5-emu	H	H/M	H	H	Y	H	H
GEM-3	H	M/L	H	H	Y	H	H
EM61HH	H	M/L	H	H	Y	H	M/H
M/M	H	H/M	H	H	Y	H	M/L
SAR	L	L	H	M	Y	H	L

* EM61-3D could also be revived (3 channels)

Developmental Systems

- ECOL
  - Benefits: resistivity system at higher frequencies, impervious to geologic clutter
  - Limitations: system maturity, production speed, durability question, must be dem-eval'd.

- Nanotem
  - Benefits: earlier time response available, 3 channels, multiple time gates
  - Limitations: same as other EMI systems, must be dem-eval'd.

Algorithms/Approaches for Data Processing - I. What is the information?

- The information which can potentially be extracted from EMI data includes:
  - Location (x, y, depth)
  - Size
  - Shape
  - Orientation
  - Composition (UXO, scrap, vs. geologic clutter)

Algorithms/Approaches for Data Processing - I. What is the information?

	Ease of Estimation	Utility
Location	EASY	H
Size	EASY	H
Shape	MODERATE/HARD	M
Orientation	MODERATE/HARD	M
Composition	EASY/MODERATE	H (geologic)

Algorithms/Approaches for Data Processing - II. Discriminating Metal from Geology

- Determine composition (UXO vs. geology) - impact could be substantial
- Sensors which require no additional processing
  - TM5-emu
- Sensors to which processing could be added (1 day post-processing turnaround)
  - GEM-3, EM63, etc.
- Issues: coverage speed versus savings

Algorithms/Approaches for Data Processing - III. Discriminating UXO from Clutter

- Conventional EM61 data in current collection mode can not be used to reliably estimate shape or orientation - thus location, depth, and size are main cues for discrimination

- Operators utilize these cues (amplitude, spatial extent)

- Automated algorithms could be applied in a post-processing framework - have shown utility elsewhere - must be dem-eval'd

Algorithms/Approaches for Data Processing - III. Discriminating UXO from Clutter

- Other sensors which provide more information could be used to obtain data (EM63, GEM-3).

- Due to complexity of the data, an algorithm will be needed to present the information to the operator

- Algorithms must be dem-eval'd

Recommendations

- **Record digital data from geophysical surveys w/ GPS**
- **Record and disseminate data for test sites, ground truth and GPS to the community for algorithm development**
  - Work with community to generate and review a test/data collection plan
  - Sequester some portion of ground truth to allow algorithm verification
- **High priority placed on the following sensors**:
  - EM63, GEM-3, MineLab
- **Medium priority placed on**
  - MTADS-MPS
- **Determine % surveyable with vehicular system**